Instrumentation for Test & Evaluation

August 2010

TEMAC T&E Refresher Course

Outline

- Role of Instrumentation in T&E
- Guidance and Forces Impacting Test Technology Instrumentation Development
- Architecture for Test Technology
- Strategy for Test Technology
- Field Data Collector Purpose and Implementatio
- The Reference Repository
- T&E Instrumentation Examples

Role of Instrumentation in T&E

- **Instrumentation is the mechanism by which:**
  - **Environments are simulated and interconnected**
  - **Network traffic loads are modeled**
  - **System Under Test (SUT) performance documented**
  - **Data are collected**
- **SUT is instrumented based upon what is available versus required:**
  - **Environments**
  - **Simulated units**
  - **Unavailable assets**
  - **Threat / interference environments**
  - **Data requirements**
- **Records both the simulated test environment and SUT's responses to that test environment**
- **Data are fused into information that is provided to decision makers…**

Instrumentation is an integral part of all ATEC Test Centers / Directorates and facilities.

Determining Instrumentation Needs

- **SUTs are instrumented when data are required to evaluate SUT capabilities**
- **How much instrumentation is determined by what data are required to:**
  - **evaluate system Key Performance Parameters (KPPs)**
  - **Validate SUT performance**
  - **determine operational effectiveness & operational suitability**
- **Data Storage and retrieval is a huge challenge being addressed by multiple initiatives:**
  - **Test Resource Management Center**
  - **Army Test and Evaluation Command**

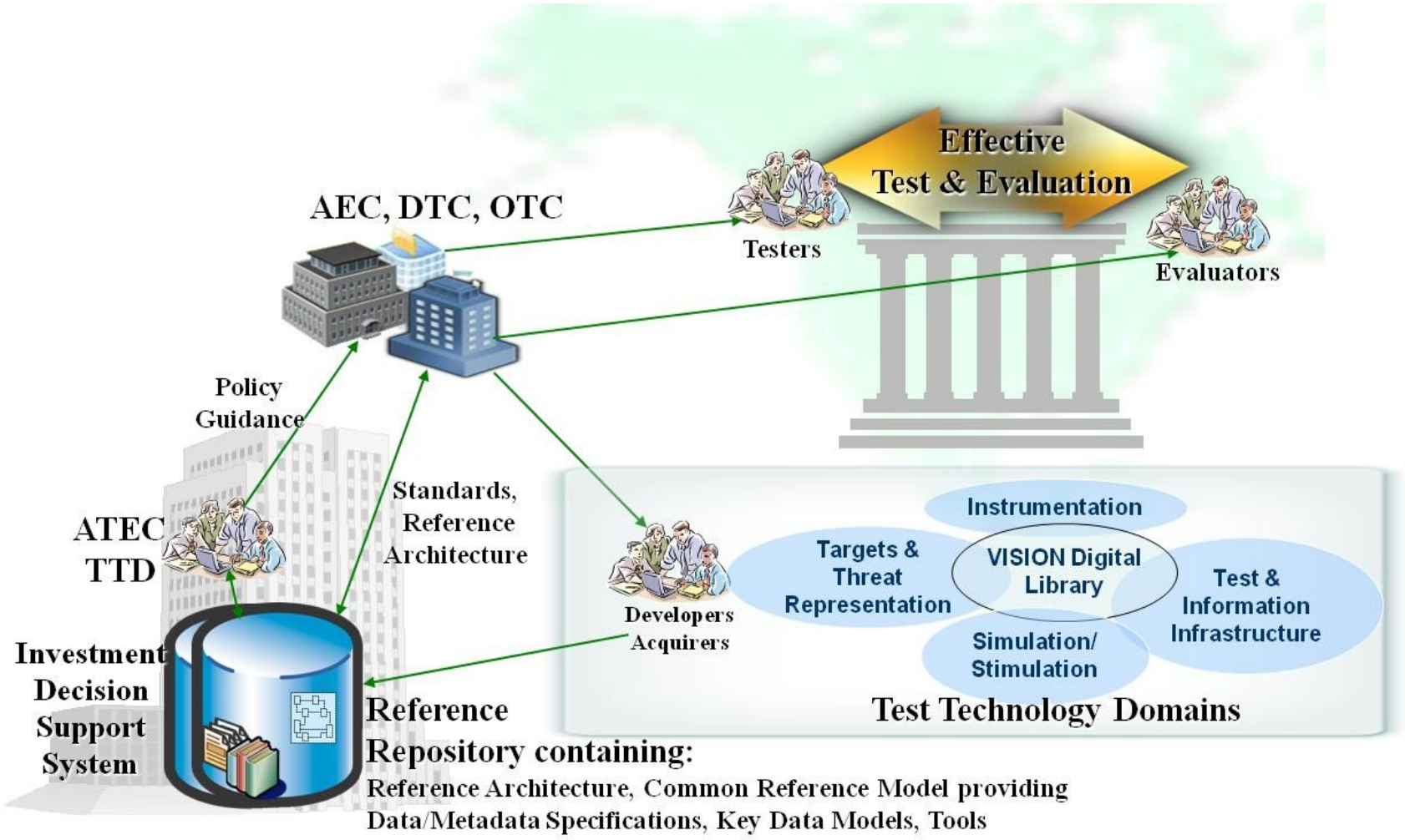
Prevailing Guidance

- **DOT&E / AT&L Testing in the Joint Mission Environment**
  - **Via distributed testing, using a set of fiber and wireless networks to link various test sites and/or centers, will change the way testing for C4ISR systems conducted**
- **“Test and Training Interdependency Initiative” Memorandum**
  - **Signed by Under Secretary of Defense for Acquisition, Technology and Logistics, the Under Secretary of Defense for Personnel and Readiness, and the Director, Operational Test and Evaluation (7 Sep 06).**
  - **Test and training communities require similar capabilities**
  - **Capabilities developed separately—not interoperable**
  - **Seeking an interdependent approach to achieve test/training mission synergies**
- **McQuery / Young 22 Dec 07 Policy Memo contained Key Areas:**
  - **Integrated DT / OT**
  - **Evaluations take into account all available and relevant data**
  - **Conduct T&E in a live, virtual, and constructive (LVC) system and operational environment continuum**

Forces

- Evolving technology has dramatically increased C4ISR Systems complexity
  - Rigorous, disciplined Test and Evaluation more critical than ever
  - Interoperability requirements for next-generation C4ISR systems are staggering
- Quantity of Data Collected is ever-increasing
- Continually Shrinking Budgets
- Customers asking why they should pay for two different instrumentation suites (developmental testing and operational testing)?

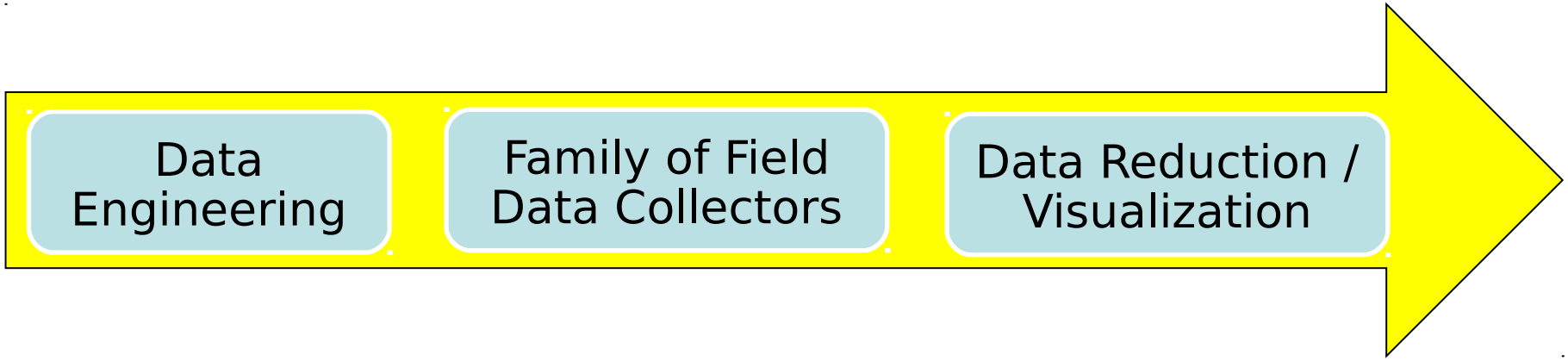
ATEC TT "To-Be" Architecture



TT – Test Technology

ATEC Strategy for Test Technology

- **Become data-centric to best support net-centricity:**
  - **Publish policy and guidelines**
  - **Provide education and training in Data Engineering**
  - **Articulate a technical approach to ATEC T&E data Family of Field Data Collectors**
  - **Provide a data-centric collaboration and reference portal**
  - **Encourage data-centric collaboration and help with Reference Repository population**
- **Synchronized, Integrated, Continuous Process**



Reference Repository

- **Data foundation of the ATEC TT Architecture**

- **Provides:**
  - **An easily-accessible, central location for data specification required for all ATEC Test Technology**
  - **A common, unambiguous understanding of the data ATEC shares or exchanges**

The ATEC Reference Repository provides a standard way to name, define, and specify all T&E data shared or exchanged throughout the Command.

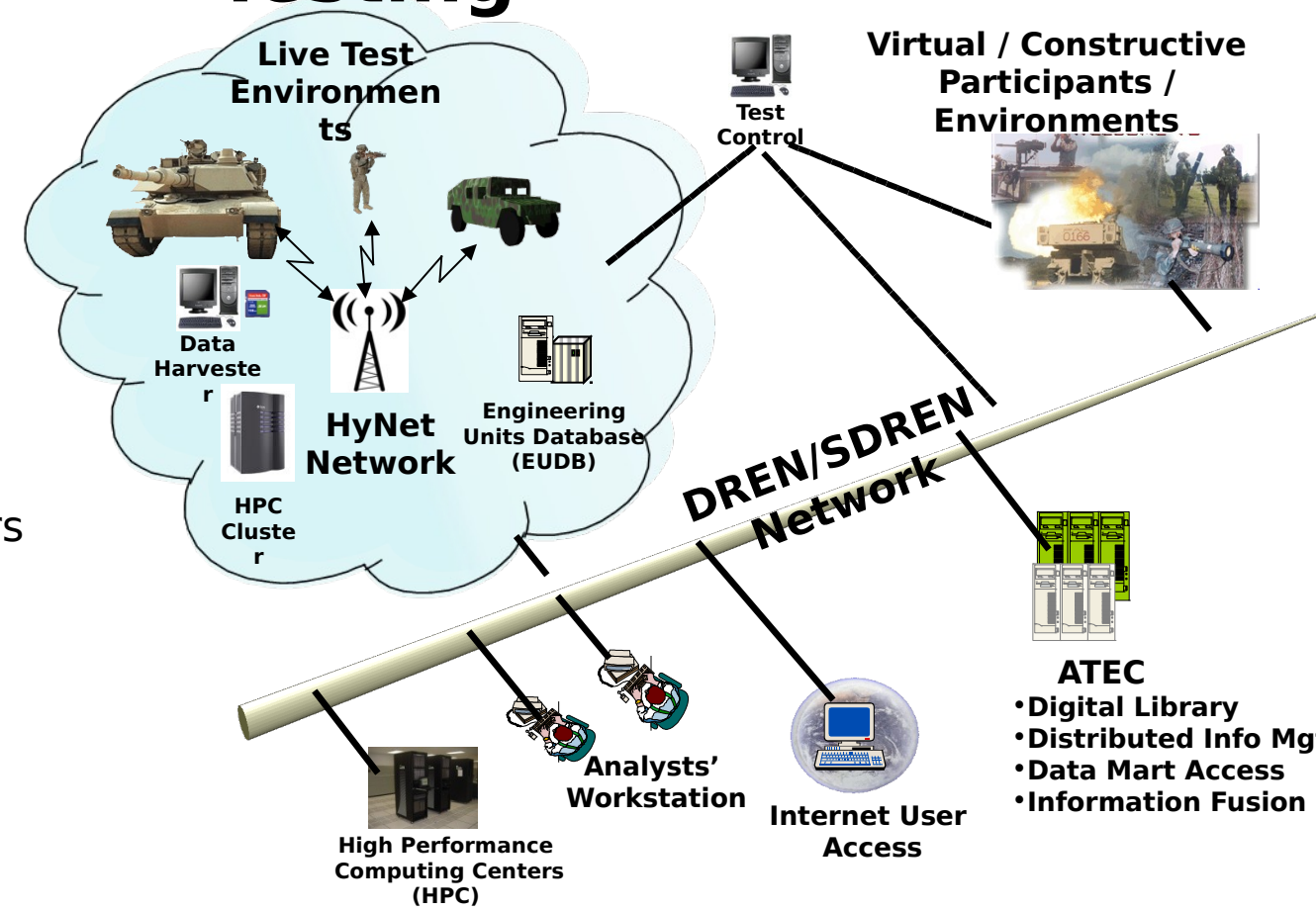
ATEC's Reference Repository – Similar to a Library

- Contains books & other materials (data artifacts)
- Loans materials (sharing and reuse)
- Knows about books in other libraries (references to artifacts owned by others)
- Provides services:
  - searching capability to locate materials (search)
  - adding new materials (submitting artifacts, data models)
  - has an established cataloging process (metadata standards, policies and procedures)
  - cataloging provides the metadata about the books (Metadata Registry)
  - request for best sellers (submit request)

Instrumentation Examples

Networked Realistic DT / OT Testing

- **Modular Instrumentation Suite** – a family of interoperable data collector / stimulator instruments networked into an integrated Data Instrumentation System.
- **Common Centralized Test Control** – Monitors and controls all collectors, stimulators, simulations, and network devices.
- **Agnostic Range Network Communication with Encryption** – Interconnect all test Instrumentation via DREN / SDREN and/or HyNet wireless TCP / IP networks with compliant

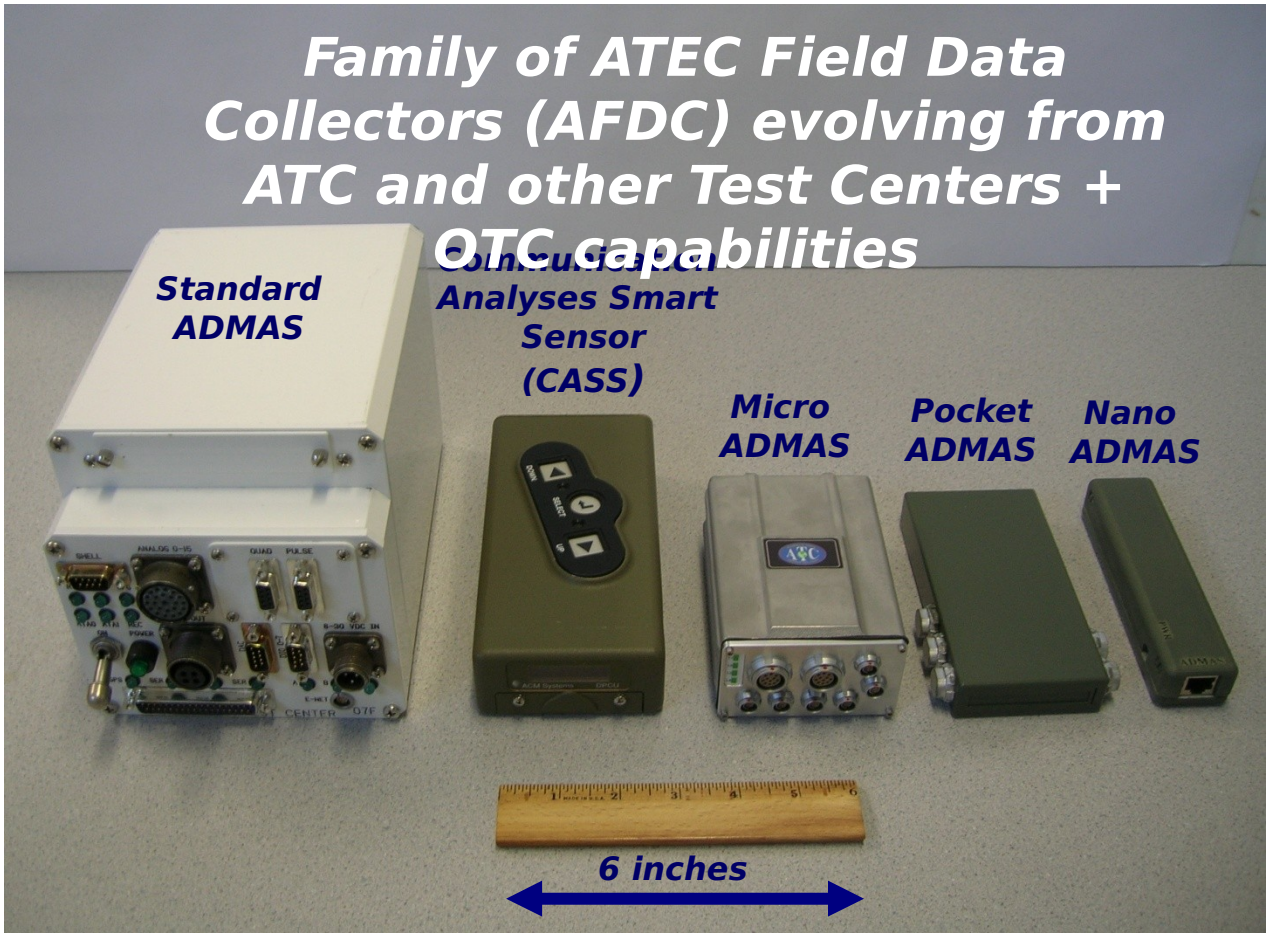


Employs a web-centric approach that merges live / virtual / constructive environments and exploits instrumentation and information management technologies

SDREN - Secure Defense Research and Engineering Network

Family of Data Recorders

- Open Source Technology
- Scalable / Interoperable
- Global Positioning System for Location and Time Synchronization
- Rugged
- On-board data storage
  32-256 gigabytes
- Data Access via public and DoD networks


Family of ATEC Field Data Collectors (AFDC) evolving from ATC and other Test Centers + OTC capabilities
Standard ADMAS
Communication Analyses Smart Sensor (CASS)
Micro ADMAS
Pocket ADMAS
Nano ADMAS
6 inches

Evolving from capabilities like those above from Aberdeen Test Center, MD

Ruggedized for Realistic DT/OT Testing

Instrumentation must be rugged, mobile, self-powered and not interfere.

Instrumentation devices were inside the protective enclosures – they kept working without loss.

OTC, Ft. Hood, TX

Real Time Casualty Assessment Sy

Vehicle Kit

I-MILES

Vehicle Control Interface (VCI) replaces RIA and FCI

Dismounted Kit

Provides automated data collection of player position location and real-time casualty assessments using unclassified weapon effects. Supports simulations of direct fire weapons, indirect fire weapons, and area weapons. Also provides an after-action-review capability and can interface into other simulations. The system allows real-time observation and control of tactical engagements.

OTC, Ft. Hood, TX

Roadway Simulator

- **World's largest automotive test simulator, supports vehicles ranging from 5,000 pound, 2-axle light vehicles to 80,000 pound tractor trailers**

- **Designed to perform vehicle dynamics, powertrain performance, shock and vibration testing in a laboratory environment**

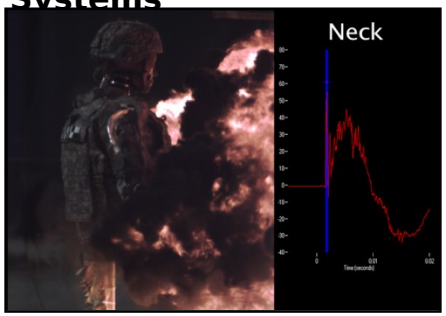
- **Adaptively constrains a vehicle at its center of gravity and provides vertical, cornering, and tractive forces to the vehicle through the tire / roadway interface using a system of special treadmills**

- **Has the Capability to test 2-axle light vehicles (up to 120 mph) , trucks with tandem rear axles and a gross vehicle weight up to 30 tons, and tractor-trailer combinations with gross vehicle weights as**

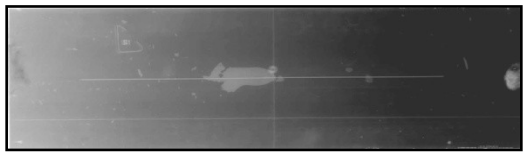
Aberdeen Test Center, MD

Imaging Instrumentation

High-speed Video Systems



Visual Synchronization of High Speed Video and Ballistic Data

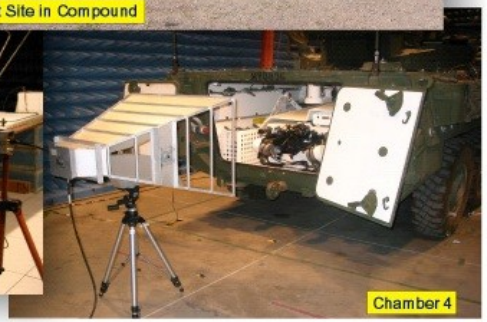


Digital Flash X-Ray Systems

Imaging upgrades at these facilities: Bomb Throwing Device (BTD), Poverty Island Mine Field (PIMF), Spesutie Island Range 18 (SI18), Anti-Aircraft Range 5 (AA5), Poverty Island Range 18 (PI18)

Aberdeen Test Center, MD

Electromagnetic Environmental Effects Testing



The Blacktail Canyon Facility conducts and evaluates Electromagnetic Interference (EMI), Electromagnetic Compatibility (EMC), and TEMPEST (referring to investigations and studies of conducted electromagnetic emission tests) on sophisticated electronic equipment and systems. Problem areas are investigated and solutions determined.

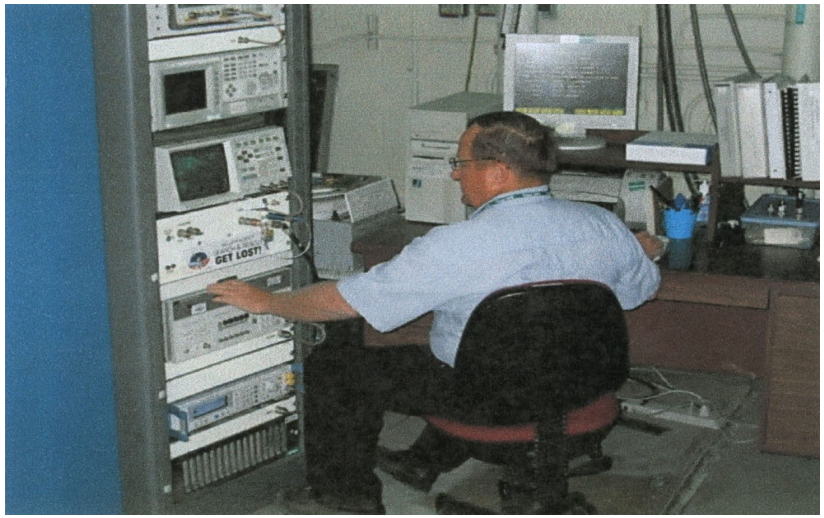
Electronic Proving Ground, AZ

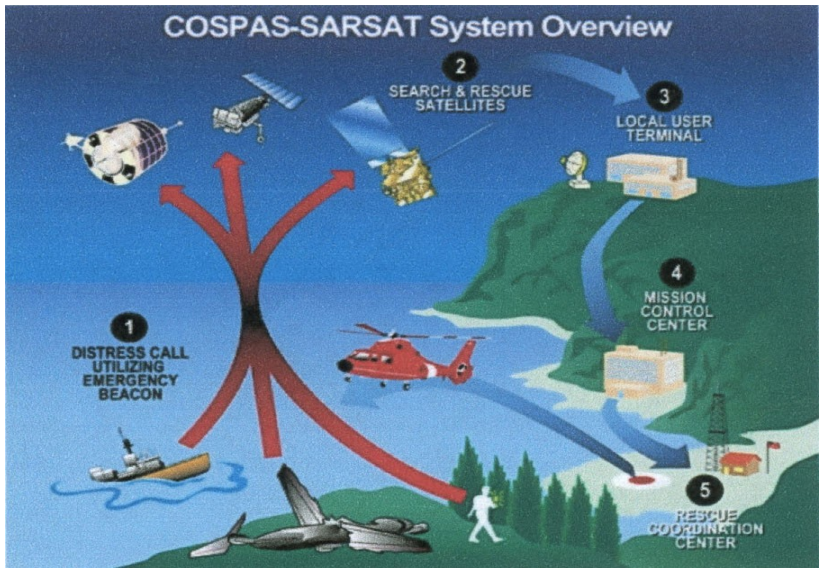
Global Positioning System Testing

The Global Positioning System (GPS) Test Facility performs a variety of testing using the GPS Instrumentation Suite (GPSIS) and specialized data collection and data reduction and analysis tools. Fort Huachuca's 80,000 acres of test range allows personnel to conduct testing in a variety of real world environments to include desert, canyon, and mountainous terrain, with or without foliage.

Electronic Proving Ground, AZ

COSPAS-SARSAT Search and Rescue Beacon Certification

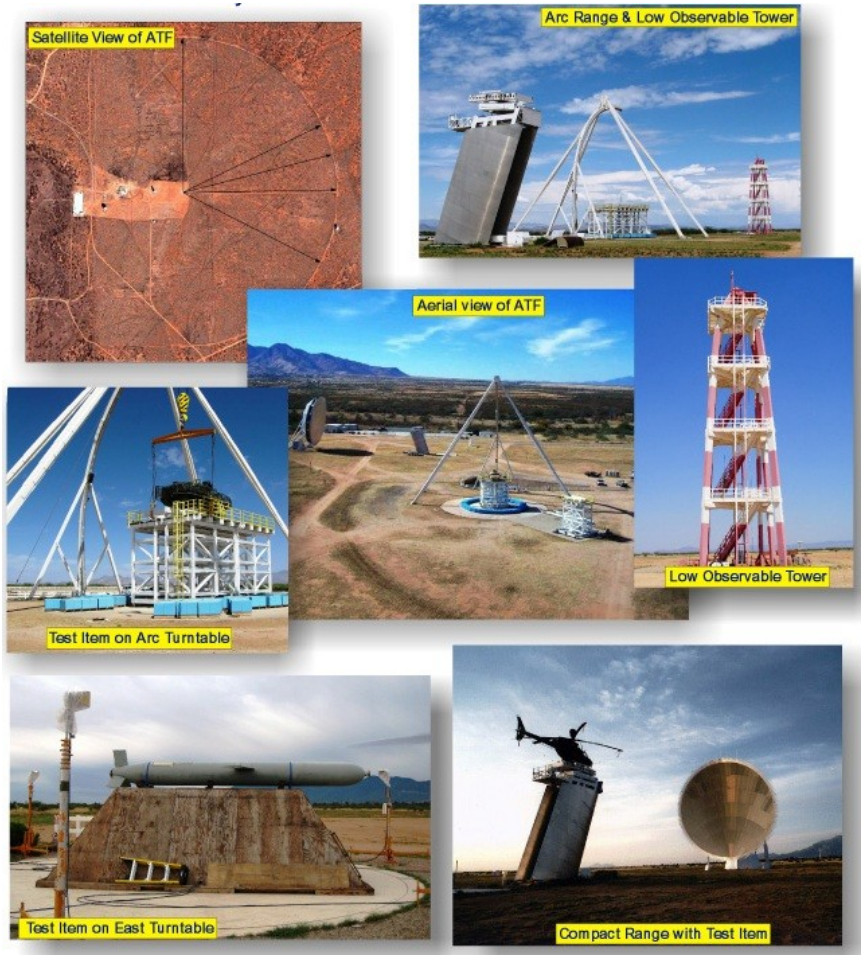




COSPAS-SARSAT is an international, humanitarian satellite based search and rescue system. Beacon certification tests include: Class I/II Environmental, Operational Test, Antenna performance, Satellite Qualitative, and Navigational.

All certification testing conducted at EPG is in accordance with COSPAS-SARSAT specifications, C/S T.007 COSPAS-SARSAT 406 MHz Distress Beacons Type Approval Standard. COSPAS stands for the Russian words "Cosmicheskaya Sistema Poiska Avariynyh Sudov" (Космическая Система Поиска Аварийных Судов), which translates to "Space System for the Search of Vessels in Distress". Search

Antenna Testing


Satellite View of ATF
Arc Range & Low Observable Tower
Aerial view of ATF
Low Observable Tower
Test Item on Arc Turntable
Test Item on East Turntable
Compact Range with Test Item

The Antenna Test Facility (ATF) measures the electrical performance of antennas either as a “stand alone” configuration or when mounted on ground or air vehicles. Sprawling over 300 acres, the ATF is composed of five main facilities: Arc Range, Low Observable Tower, Two Turntables and the Compact Range. Data collected includes antenna radiation patterns (beam width, side lobe, electrical bore sight, mechanical bore sight), antenna radiation pattern subsets (relative antenna gain, absolute antenna gain, directivity), frequency Bandwidth and special customer tests.

Electronic Proving Ground, AZ

Chemical / Biological Testing

Challenging the system or new technology under test and their operation under controlled sampling conditions provides a thorough data base of performance parameters in which to evaluate capabilities. sophisticated electronic equipment and systems. Problem areas are investigated and solutions determined. Tests can be designed to determine the volume of agent dispersed on the ground and in the air during the demolition. This data can then be used as source data for various models to determine the dosage, exposure and extent, if any, of agent dispersed.

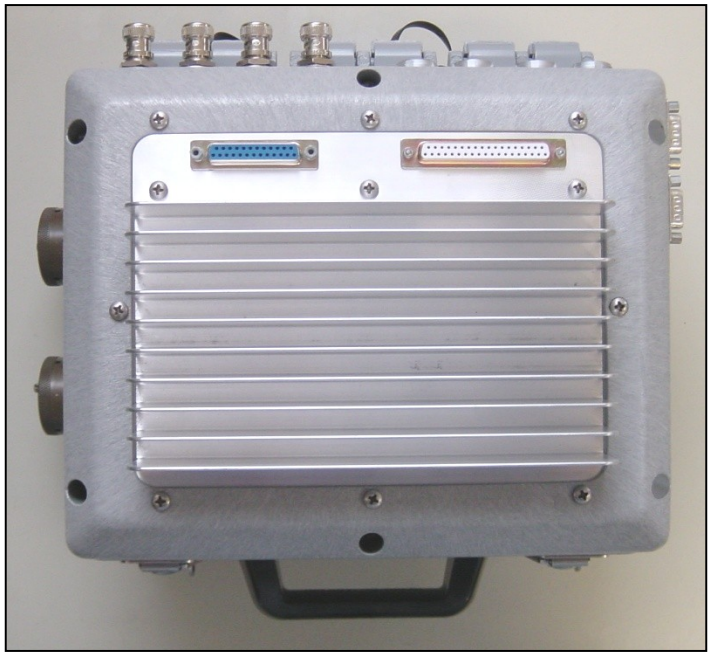
Dugway Proving Ground, U

Range-In-A-Box (RIAB)

The RIAB was designed to provide five key functions:

1. **Data acquisition**
2. **Unit Under Test Control/Stimulus**
3. **Unit Under Test Status Monitoring**
4. **Target Remote Driving**
5. **Range safety**

High Operating tempo and numerous test programs at RTC drives the requirement for this ruggedized system that can be easily reconfigured on a daily / weekly basis



- **Supports Developmental Test, Operational Test, Marine and Foreign Military Sales testing**
- **Provides Passive Digital Video and Data Collection, Engagement Playback, Remote Steering of test and target vehicles, etc.**

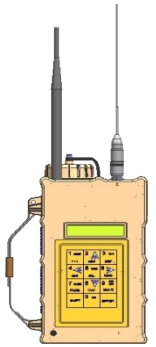
Compact Field Data Collector (CFDC)

Features

- Collects the high & low speed data busses for a minimum of 16 hrs
- 24 hr rechargeable battery life
- Tested at Mil. Spec. environments
- Sub 3m GPS unit
- Sub ms time stamping capability
- Unobtrusive and autonomous design allow use in an OT environment
- Real time control and status through 802.11 wireless transceiver, Starship and Test & Training ENabling Architecture
- Wireless connectivity through Mobile Node Infrastructure
- CFDC Application Tool Set is integrated with EPG, WSMR, and ATEC test tools
- Collected data provided to Huntington Beach data Management team and Mobile Node analysis
- Acts as a GPS transponder and logger

Upgrade Paths

- Two board design – (1) System interface / data storage and (2) GPS / Wireless Ethernet
- Either board could be replaced to interface with new



U-UGS GW

T-UGS GW

T-UGS ISR

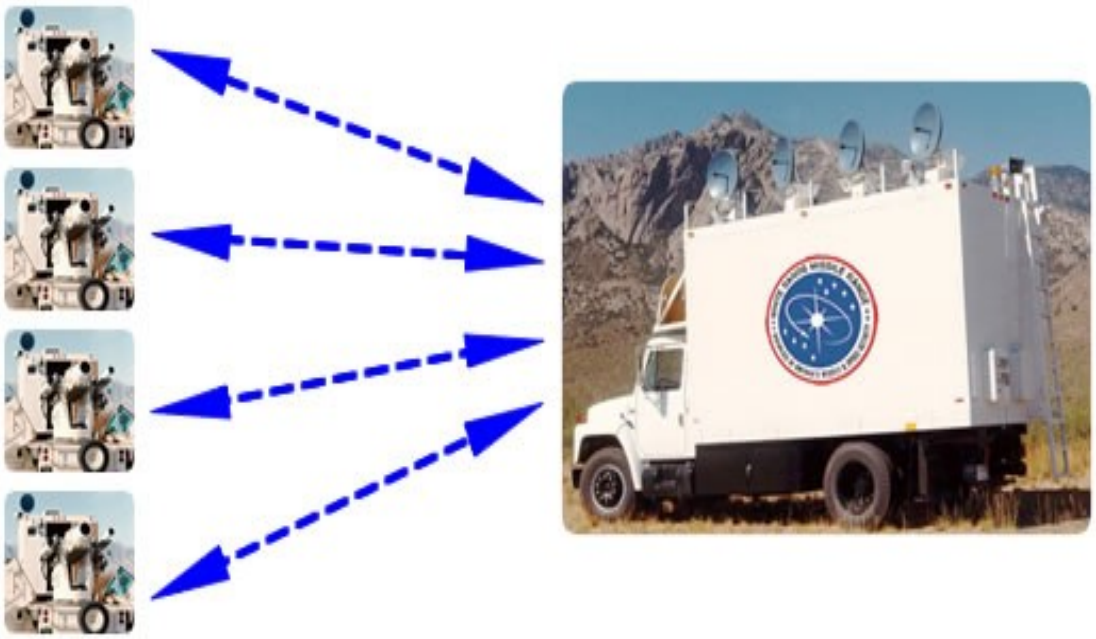
58 CFDCs developed for Operational Test Command to collect Unmanned Ground System message traffic

Fencepost: Ground Truth Seismic & Acoustic System

- **5 microphone array**
- **Self-locating via GPS**
- **Self-orienting via electronic compass**
- **Wired or wireless communication**
- **3-axis seismometer added for Exp 1.1**
- **Tracks ground or air targets**
- **Power by battery and solar**
- **Used in conjunction with the Compact Field Data Collector during Future Combat Systems SpinOut-1 Technical Field Test**

Provides critical **ground truth** data for **decision** makers to evaluate the capabilities of tactical seismic and acoustic sensors

Remote Instrument Control System



RICS instrumentation vans consist of a truck-mounted van body which houses a four (4) station remote control system.

Self-propelled systems pull their own generator trailers.

Controls Up To 4 Remote Tracking Systems.

Remote Control Range In Excess of 15 miles.

Generates Real-time 60 Per N-Station Solutions.

Produces Real-time Time Space Position Information to 1 Meter Accuracy On Some Targets (Depending on Size & Dynamics)

- Controls Up To 4 Remote Tracking Systems
- Remote Control Range In Excess of 15 Miles
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- Produces Real-time Time Space Positioning Information to 1 Meter Accuracy On Some Targets (Depending on Size & Dynamics)

AN/MPS-39 MOTR Radar

The AN/MPS-39 Multiple Object Tracking Radars are White Sands Test Center´s most modern instrumentation radars. They are phased array radars, each capable of simultaneously tracking up to 40 objects within a scan volume of 60 degrees by 60 degrees. The MOTR radar collects range, azimuth and elevation to the object being tracked as well as XYZ (East, North, Up) distances from the radar.

White Sands Test Center, NM

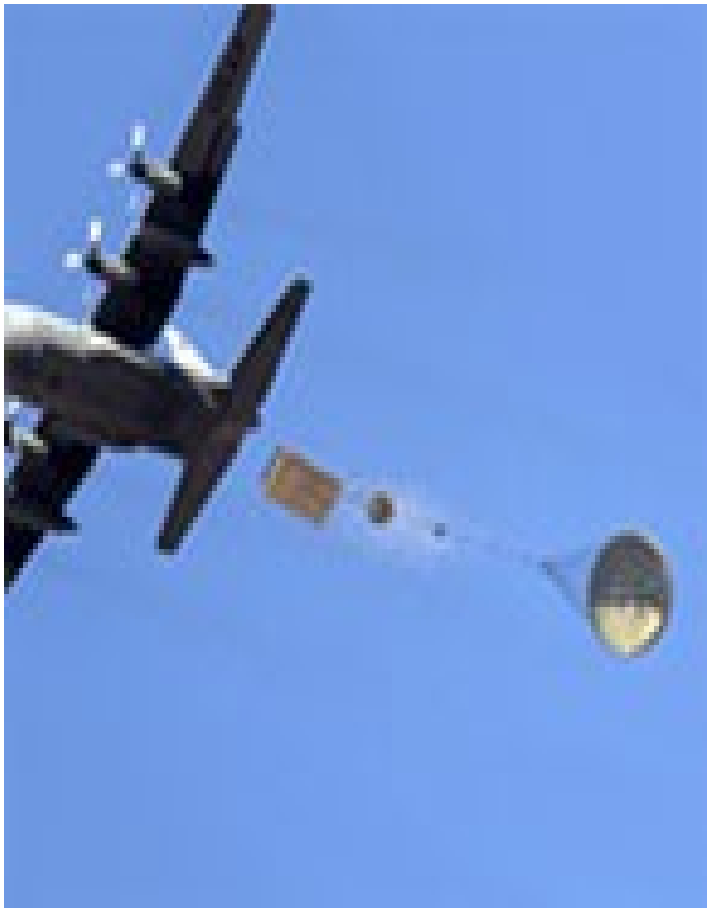
Weapons & Ammunition Testing

KOFA Firing Range, YPG, AZ has several test areas including the Main Front Area, with 21 permanent firing positions, ammunition storage and preparation, and environmental simulation facilities; the Terminal Ballistics Evaluation Area, with prepared and instrumented impact areas; and the Extended Range Munitions Area, with maximum range attainable of 75,000 meters, with 65,000 meters under tracking surveillance.

INSTRUMENTATION

- **Tracking and Doppler Radars**
- **Telemetry**
- **GPS Reference**
- **Flash X-Ray**
- **Velocity**
- **High Resolution Film & Video**
- **Breech Pressure**
- **Optical & Infra-Red Imaging and Tracking**
- **High Speed Film & Video**
- **Computational Facility**

Air-to-Ground Testing



The Cibola Range, YPG, AZ is a fully instrumented air-to-ground aircraft armament test range with electronic and optical instrumentation, including six precision aircraft tracking systems, tracking radar's, and video scoring. The range has six sites from which the position of missile-firing aircraft can be established and trajectories measured.

INSTRUMENTATION

- Flight Dynamics Data Collection
- Precision Tracking Radars
- Laser Trackers
- Adaptive Vehicle Data Acquisition
- Telemetry
- GPS Satellite Monitoring Station
- Ballistics Instrumentation
- Fuse and Warhead Function
- Environmental Simulation
- Atmospheric Characterization

Cold Regions Testing

Bolio Lake Test Complex provides automotive cold start capabilities and a base for Soldier equipment tests. Ranges are also available for mine, explosives, small arms tests, direct fire tests, sensor testing, air defense, missile, artillery, smoke and obscurant tests, and mobility testing. CRTC can accommodate indirect fire testing with the capability of observed fire to 30 km and unobserved fire to 50 km. Indirect fire, up to 100 km, can also be accomplished by utilizing ranges near Fort Wainwright, Alaska with the impact on Fort Greely areas. Supporting infrastructure include a facility for surveillance testing, ammunition storage area, administrative areas, communications circuits, meteorological sites, and an extensive network of roads and trails. Airfield-based and tactical

Airborne, Airdrop, Joint Special Operations Forces Testing

State-of the art <u>instrumentation</u> records all visual action from exit to ground impact and recovery:

- **Ground-Based Video Tracking Systems.**
- **Aerial photography from T-34 chase aircraft or paratrooper helmet-mounted cameras.**
- **Global Positioning System (GPS)-based instrumentation attached to jumpers and equipment loads.**
- **High-speed video-graphy and digital still photography.**

Airborne Special Ops Test Directorate, Ft. Bragg

Acknowledgement & Feedback

This module is a part of the T&E Managers Committee (TEMAC) T&E Refresher Course.

Request your feedback. Please contact -

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